Syllabus: ECE652 Safety-critical Real-time Software

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Course Title: Safety-critical Real-time Software
Course Short Title: Safety-crit RT Software
Instructor: Prof. Sebastian Fischmeister

1 Calendar Description
Concepts, theory, tools, and practice to understand, design, and write embedded software. This covers topics such as embedded computing hardware, embedded computing software, modeling of timing and real-time systems, dependability and safety, security, validation, and performance of embedded systems.

2 Prerequisite Topics
computer architecture, operating systems, programming languages, C

3 Prerequisite Courses
• Operating systems course
• Compilers course
• Programming course

4 Antirequisite Courses
• ECE455 Embedded Software

5 Lab Description
No lab this year

6 Tutorial Description:
No tutorials this year

7 Project
None this year

8 Reading Material
Disclaimer: Not all material listed. See the headings for the slide material.


Examples taken from:


Extra reading:


9 Major topics

Part 1: Embedded computing

- Lecture syllabus
- Embedded systems are difficult
- Instruction sets
- Computing units
- Embedded computing platforms
- Embedded system debugging

Part 2: Timing

- Reference model for real-time system
- Common approaches to scheduling
- Worst-case execution time problem
- Clock-driven scheduling
- Priority-driven scheduling
- Programming timing constraints

Part 3: Safety

- Overview of dependable systems
- Software fault tolerance
- Interrupt scheduling
- Byzantine Generals
- Basics of software qualification
- Basics of safety assessment
- ISO 26262 & IEC 62304

Part 4: Security

- Security overview
- STRIDE/DREAD
- String vulnerabilities
- Integer vulnerabilities
- Formatted output vulnerabilities
- Concurrency vulnerabilities
- Recommended security practices

Part 5: Correctness analysis

- Invariants and temporal logic
- Equivalence and refinement
- Reachability and model checking

Part 6: Performance analysis

- Introduction to benchmarking
- Common mistakes
- Performance metrics
- Probes and monitors
- Ratio games and visualization + demo
10 Grading

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Quiz 1-3</td>
<td>50</td>
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<tr>
<td>Final</td>
<td>50</td>
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- Best two of the three quizzes will count.
- You have to achieve at least 50% in each category
- In borderline cases, based on the instructor’s assessment, points can be traded 3:1.

11 Disclaimer

1. Academic Integrity
   In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. Check [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/) for more information.

2. Grievance A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). When in doubt please be certain to contact the department’s administrative assistant who will provide further assistance.

3. Discipline
   A student is expected to know what constitutes academic integrity [check www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/) to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about 'rules' for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, [Student Discipline, www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm).

4. Appeals
   A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) [www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm).

5. Note for Students with Disabilities
   Please register with the office and they will send me a notice.

12 Notes

- June 14, 2018: updated the reading material list to point to the book chapter of J. Regehr instead of the paper.